956,894

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in Axially Slidable Shaft and like Joints or Couplings

We, DAIMLER-BENZ AKTIENGESELLSCHAFT, of Stuttgart-Unterturkheim, Germany, a Company organised under the laws of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an axially slidable shaft or like joint or coupling, particularly for motor vehicles, of the kind in which joint parts connected respectively to driving and driven members, are provided with inclined grooves, antifriction balls guided in a cage being engaged between opposed grooves for the transmission of the torque. Joints or couplings of this kind are sometimes known as synchronising joints.

The invention has for its object to improve and simplify joints of the kind referred to so that they can be used more advantageously for power transmission in motor vehicles, for example for driving the steered wheels of vehicle with front wheel drive.

According to the invention, each part of the joint has disposed in it a number, divisible by two, of helical grooves located in a cylindrical surface, and preferably of large pitch, the grooves being alternate of left-hand and right-hand pitch, and each ball being guided in a groove having of left-hand pitch in one joint part and a groove of right-hand pitch in the other part.

This improved arrangement provides for precise synchronism of the balls being in engagement at the same time in every axial position of the parts and in each direction of rotation. Also, rolling friction occurs in the main direction of loading and no axial forces act externally of the joint. Finally, joint parts of short length and small diameter can be achieved and the joints can be manufactured easily and economically.

One part of the joint may be a sleeve having a cylindrical internal surface and the other part, which enters the sleeve, may be provided with a double conical external surface with the bases of the cones towards one another and a rounded transition between the said bases. The cage for the balls may have its internal and external surfaces doubly conical form with a rounded transition.

In a modification, both parts of the joint may have the aforesaid doubly conical and rounded formation, the cage for the balls in this case being a cylindrical sleeve.

The openings in the cage for guiding the balls are dimensioned so that in the axial direction they correspond to the diameter of the balls but, in the peripheral direction, have a length greater than the said diameter.

Surfaces in the cage for guiding the balls in the axial direction may be made deeper in the radially inward direction at the openings for the balls. In one arrangement bands or webs extending axially may be formed on the internal surface of the cylindrical cage. In another arrangement, the material at the edges of the openings may be bent inwardly of the cage.

The accompanying drawings illustrate examples of the arrangements embodying the invention and in these drawings:—

Figure 1 is a longitudinal section through a joint in which the sleeve part of the joint is cylindrical, but the ball cage and inner joint part have a double conical formation.

Figure 2 is a developed plan or diagram illustrating the positions of the balls engaged in the grooves and slots of the parts seen in Figure 1.

Figure 3 is a longitudinal section through a modified arrangement in which the sleeve part presents a double conical formation and the cage is cylindrical.

Figure 4 is an exploded perspective view of the joint in Figure 3,

Figure 5 is a perspective view of a modified cylindrical cage,

Figure 6 is a cross section on the line VI—VI in Figure 5, and

Figure 7 is a cross section similar to Figure 6 of a further modified cylindrical cage.

The axially slidable synchronising joint or coupling shown in Figure 1 comprises a sleeve part 1, a male part 2 inserted in the sleeve part 1, balls 3 for transmitting torque from one part to the other, and a ball cage 4.

From Figure 2, it can be seen that the interior 6 of the sleeve 1 is formed with helical grooves 5, 5^1 of large pitch, the grooves 5 being of left-hand pitch and alternating with the grooves 5^1 of right-hand pitch. The total number of the grooves 5, 5^1 must be divisible by two. Similarly, corresponding grooves 7, 7^1 are formed on the cylindrical external surface 8 of the male part 2. Each ball 3 lies in a groove 5 of left-hand pitch in the sleeve part 1 at the point of the intersection of such groove 5 with a groove 7^1 of right-hand pitch in the male part 2, or in a groove 5^1 of right-hand pitch in the sleeve part 1 and at the point of the intersection of such groove 5^1 with a groove 7 of left-hand pitch in the male part 2.

As shown in Figure 1, the internal surfaces 9 of those portions of the sleeve 1 which lie between the grooves 5, 5^1 are cylindrical, while the external surface 10 of the male part 2 has the form of a double cone with the conical parts base towards base, a rounded transition 11 being provided between the bases. The cage 4 for the balls 3 is also provided both at its outer surface 12 and at its inner surface 13 with a similar double conical formation and a rounded transition. In the cage 4, slots 14 for the balls 3 are provided and these slots have a width, in the axial direction of the joint, about equal to the diameter of the balls 3, whilst their length in the peripheral direction is greater.

The intersections of associated grooves 5, 7^1 or 5^1, 7 in the sleeve 1 and on the male part 2 determines the positions of the balls 3 which, due to the cage 4, all lie in one plane of cross section, as for example the plane marked 16 in Figure 1.

On axial displacement of the male part 2 in relation to the sleeve 1 by, for example, the distance 15 in Figure 1, the points of intersection of each two associated grooves, 5^1, 7 or 5, 7^1, and hence the balls 3 situated at such points are displaced by half the distance, substantially in the same way as the ball cage of a ball bearing turns at half the speed of the inner race. On axial displacement, therefore, the cage 4 moves half as far as the inner body 2. On the other hand, if the joint is bent, for example through the angle α, the mean plane of the cage 4 and hence of the ring of balls 3 is displaced into a plane 16 through a half of the angle of bending, so that synchronism is achieved.

Since half of the grooves in each part have a left-hand pitch and the other half a right-hand pitch, the axial forces or axial components of the forces acting between the balls 3 and the groove neutralise each other inside the joint and therefore there is no axial component acting externally. The cage 4 has no special guidance, but is held only by the balls 3 themselves. It is, however, advantageous for it to bear against the cylindrical surface 9 in order to avoid rattle.

With any symmetrical angular and axial movement of one part of the joint in relation to the other (i.e. of the sleeve 1 in relation to the male part 2), for which the plane of the balls 3 in the starting position is the plane of symmetry of the movement, the balls 3 remain in that plane of symmetry. At the same time, all the balls 3 contribute fully to the transmission of the torque, irrespective of the direction of rotation.

The sleeve 1 may be helically broached and, after hardening, may be ground with a relatively large grinding wheel set at an angle. It is not necessary for the balls 3 to bear on the entire bottoms of the grooves 5, 5^1; 7, 7^1. Bearing against the flanks of the grooves is sufficient. The grooves in the male part 2 may be milled, for example by hobbing, and ground after hardening. The cage 4 may be formed from a tube and the slots 14 may be broached.

The joint illustrated in Figures 3 and 4 differs from that of Figure 1 mainly in that the inner surface 9^1 of the sleeve 1 has the above-described double conical formation with a rounded transition 17 between the bases of the cones and the cage 4^1 is a cylindrical tube. This joint is somewhat simpler to produce than that of Figure 1. In addition, rather deeper grooves 7, 7^1 are obtained in the inner body 2, so that better bearing of the balls 3 results. Otherwise the joint has the same manner of operation as the joint of Figure 1.

A different form of the cage 4^1 of Figure 3 is illustrated by Figures 5 and 6. In that region of the cage 4^1 in which the balls 3 are guided in the axial direction in the slots 14, bands or webs 18 are provided on the inside of the cage, so that the guiding surfaces 19 are deepened radially inwards at the said slots. It is thus possible to make the cylindrical cage 4^1 larger in diameter and to make the grooves 7, 7^1 in the male part 2, which would not otherwise be as deep, of the same depth as the grooves 5, 5^1 in the outer part. Heavier wear of the male part is thus avoided. For the same purpose, the material of the sleeve 4^1 may alternatively be bent radially inwards, as shown at 20 in Figure 7.

WHAT WE CLAIM IS:—

1. An axially slidable joint in which the coacting joint parts connected to driving and driven members are provided with helical grooves in which balls guided in a cage are provided for transmitting the torque, each part of the joint being provided with a number, divisible by two, of helical grooves located on

a cylindrical surface, which grooves have alternately left-hand and right-hand pitch, and each ball being guided in one part of the joint in a groove with a left-hand pitch and in the handpitch.

2. A joint according to claim 1, wherein one part of the joint is a sleeve with a cylindrical internal surface and the other part is a male part with an external surface of the form of a double cone with a rounded transition and the cage has internal and external surfaces of the form of a double cone with a rounded transition.

3. A joint according to claim 1, wherein one part of the joint is a sleeve with an internal surface of the form of a double cone with a rounded transition, the other part is a male part with its external surface of the form of a double cone with a rounded transition and the cage is a cylindrical sleeve.

4. A joint according to any one of claims 1 to 3, wherein openings in the cage for guiding the balls have a dimension in the axial direction substantially equal to the diameter of the balls, but have a larger dimension in the peripheral direction.

5. A joint according to claim 3 or 4, wherein the surfaces in the cage for guiding the balls in the axial direction are made deeper in the radially inward direction.

6. A joint according to claim 5, wherein bands or webs extending in the axial direction are provided on the internal surface of the cylindrical cage, so as to make the guiding surfaces deeper at the openings for the balls.

7. A joint according to claim 5, wherein the material of the cylindrical cage is bent inwardly in the region of the surfaces for guiding the balls in the axial direction.

8. A joint substantially as hereinbefore described with reference to Figures 1 and 2, Figures 3 to 6 or Figure 7 of the accompanying drawings.

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Fig.1

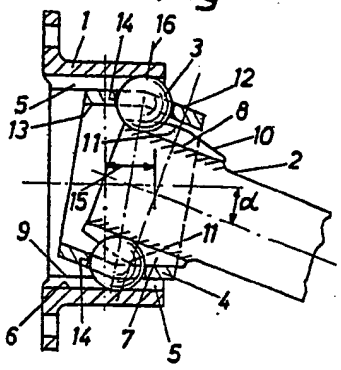

Fig.2

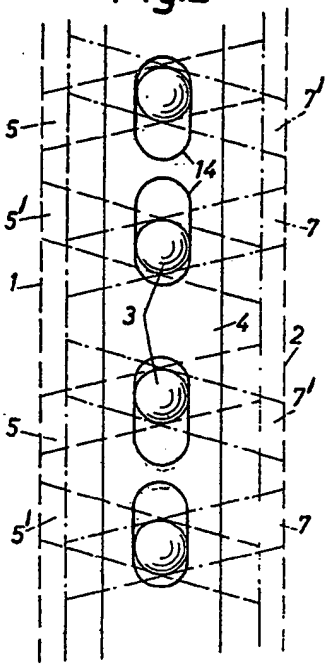

Fig.3

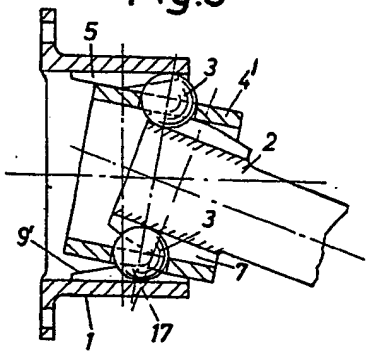

Fig.5

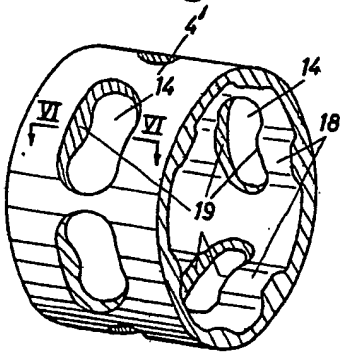

Fig.6

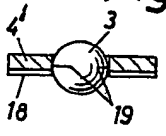

Fig.7

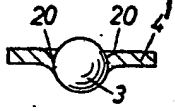

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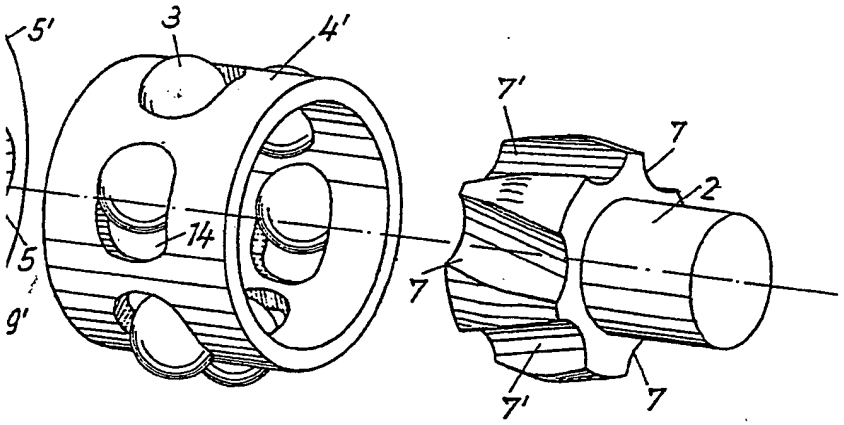
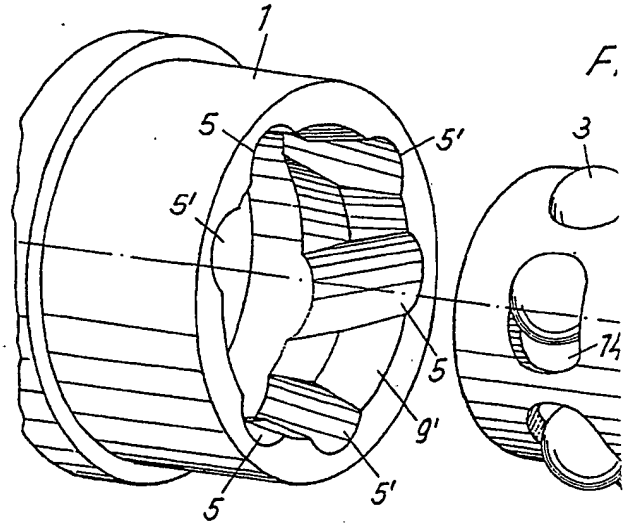
Fig. 4




1
5
5'
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Sheet 2

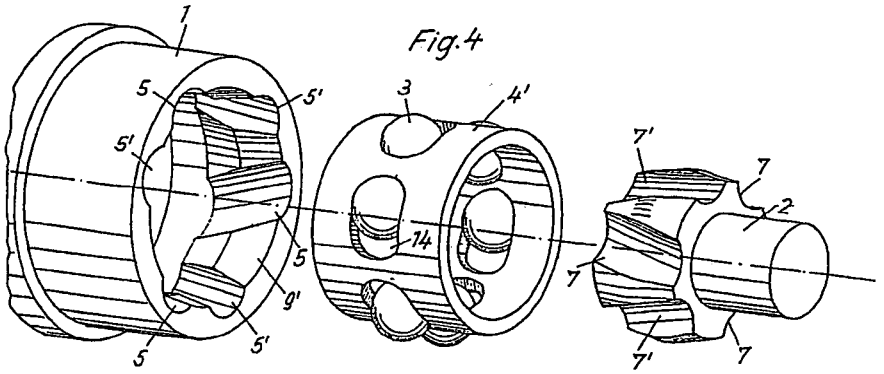

Fig.4